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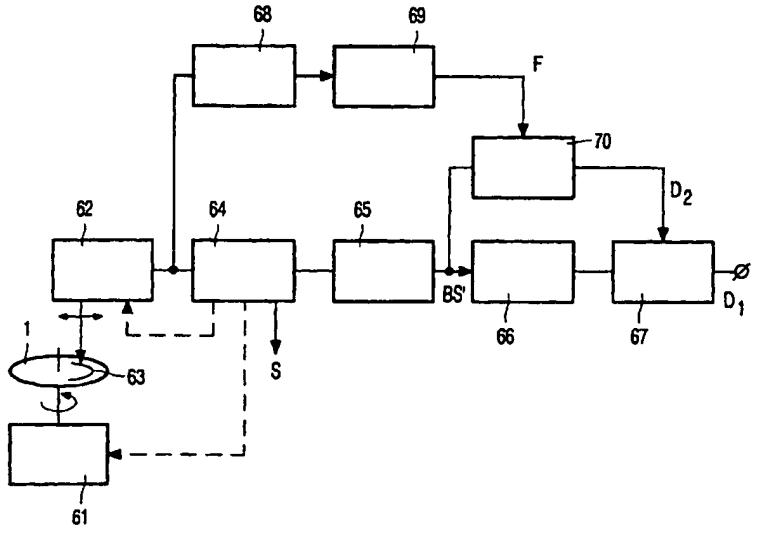
(54) Title: ADDITION OF WATERMARK KEYS ACCORDING TO A FLEXIBLE FORMAT



(57) Abstract: A method for embedding supplemental data in an encoded signal that is different from the format used for encoding data of the encoded signal and recording said signal on a disc-like record carrier by applying marks of a first physical type. The supplemental data is encoded in accordance with a second format that is different from the format used for encoding data of the encoded signal. Format description information related to the second format is recorded on the record carrier with either marks of the same physical type but modulated in accordance with a second, different modulation or with marks of a second type having different physical characteristics with respect to the first type.

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Addition of watermark keys according to a flexible format.

The invention relates to a method for embedding supplemental data in an encoded signal and recording said signal on a disc like record carrier as recited in the preamble of claim 1. The invention further relates to an arrangement for performing the method, a disc like record carrier obtained with the method and an arrangement for reproducing data recorded on such a disc like record carrier.

There is a growing need to accommodate supplemental data in audio and video signals. Watermarks are supplemental data messages embedded in multimedia assets, preferably in a perceptually invisible manner. They comprise information, for example, about the source or copyright status of documents and audiovisual programs. They can be used to provide legal proof of the copyright owner, and allow tracing of piracy and support the protection of intellectual property.

A known method of embedding supplemental data in an encoded audio and video signal without substantially effecting the perceptual quality is disclosed in European Patent Application Number 98900036.9, document D1 in the list of referred documents that can be found at the end of this description. Herein is disclosed the encoding of an audio signal with an unity bit encoder, such as a sigma-delta modulator as envisaged for recording high quality audio on the audio version of the Digital Versatile Disk (DVD). Such an encoder produces an output stream comprising a one-bit output sample for each encoding step in contrast to a multi-bit sample. A digital watermark pattern is inserted by replacing selected bits, for example each 100th bit of the output stream, by bits of a digital watermark pattern.

This approach is quite vulnerable for piracy. The format of the embedded data has to be fixed because a decoder is built in hardware in a player. All discs will be coded according this format. A possible pirate gets a lot of material coded with this fixed format. Once the pirate knows the coding format, he can decode all future content and develop techniques to circumvent all protections.

European Patent 706 174, document D2 in the list of referred documents that can be found the end of this description, discloses measures for preventing illegal copying of

an output stream recorded in the form of pits on an optically readable recording medium such as a CD-ROM. The disclosed measures comprises determination of a unique physical characteristic of a disk, encrypting this information and writing it optically or magnetically on a disc in such a manner that it is distinguishable from the main information recorded on the disk. At reproduction of the main information, the physical characteristic of the disk is measured again and checked with the enclosed physical information so as to make a decision as to whether or not a specific relationship is present there between. Such physical information may be a pit angular arrangement, a pit depth and tracking quantity, a second low reflection section, dust position and so on. However, for each disk said physical characteristic has to be measured, which complicates production. Furthermore, no predetermined watermark information can be embedded in this way.

In consequence, amongst other things, it is an object of the invention to obviate above-mentioned disadvantages. According to one of its aspects a method according to the invention is characterized as recited in the characterizing part of claim 1.

This allows a flexible format for embedding the embedded data, which format can be specific for each record carrier or a group of record carriers. When a pirate knows the format of the embedded supplemental data for one record carrier, he doesn't know this of other discs. A secure protection is obtained by placing a description of said flexible format in other appearance on the record carrier. Such as obtained with a different modulation of marks of the same physical type, for example either optical or magnetic. Or with marks of a different physical type, either optical or magnetic. Generally, a bit copying machine usually only copies the variations of a first physical parameter obtained with the first modulation process as these variations represent the recorded main information. Only dedicated reproducing devices will be capable of detecting the variations of a second physical parameter such as obtained with the second modulation process.

Further advantageous aspects of the invention relating to an arrangement for embedding supplemental data on a disc like record carrier, a record carrier and an arrangement for reproducing data on such a record carrier, are recited in the independent claims 13, 24 and 35 respectively.

A further advantageous aspect of the invention is recited in claim 2. This allows combining the recording means for both signals in a large extent. In addition, recording means as well as reproducing means may be combined also.

Several advantageous embodiments employing modulation of the same local areas are recited in dependent claims 3, 4 and 5.

Further advantageous aspects of the invention are recited in the other, dependent claims. A particular advantageous embodiment is recited in claim 7.

These and further aspects and advantages of the invention will be apparent from and elucidated in more detail hereinafter with reference to the disclosure of preferred embodiments, and in particular with reference to the appended figures in which,

Fig. 1 illustrates a record carrier of the optical readable type provided with optically detectable marks;

Fig. 2 shows an arrangement according to the invention for recording encoded data and supplemental data at a record carrier as illustrated in Fig.1;

Fig. 3 shows in more detail an embodiment for modifying an encoded signal;

Fig. 4 shows an example of a modified encoded bit stream;

Fig. 5 shows an arrangement according to the invention for reproducing encoded data and extracting supplemental data from a record carrier as illustrated in Fig.1;

Fig. 6 shows in more detail means for extracting supplemental data from a stream of encoded data and supplemental data and

Fig. 7 illustrates a method according to the invention for embedding supplemental data in an encoded signal.

Fig. 1 illustrates a possible embodiment of a record carrier 1 of the optical readable type for use in accordance with the invention. Fig. 1a is a plan view illustrating the arrangement of optically detectable marks along a track of which the centerline is indicated by a reference sign 2. Fig. 1b shows a highly enlarged plan view of a part 3 illustrating the optical detectable marks 4 arranged along the track 2 and the intermediate areas or spaces 5. The optically detectable marks 4 may be in the form of local depressions or so-called pits. However also other types of optically detectable marks are suitable such as for instance as obtained with phase-change materials. The marks 4 result in a modulation of reflected light intensity of a radiation beam scanning along the track 2. In Fig. 1c a signal 6 is given representing this modulation for the event that the pattern of marks 4 and spaces 5 is scanned along the track 2 with a constant linear velocity. The lengths of the marks 4 along the track 2

and of the intermediate spaces 5 correspond with a plurality (including one) of bit cells of the signal 6. The length T of a bit cell corresponds with the period T of the data clock of the signal 6. In Fig. 1b a bit cell is represented by a track part with a length L.

However, other types of modulation may be obtained as for instance disclosed in the European Patent Application Number 91203147.3, in the name of applicant, document D3 in the list of referred documents that can be found at the end of this description. Fig. 1d illustrates for example an embodiment employing variations of the width of the optical detectable marks 4. This causes an additional intensity modulation in a radiation beam scanning along the track 2 resulting in two components in the corresponding signal 6. When the frequency spectrum of the component caused by the length modulation does not overlap the frequency spectrum of the component caused by the width modulation, information represented by either modulation can be recovered separately. Fig 1e shows an embodiment employing variation of the track position in a direction transverse to the track 2. This position modulation has the form of a track undulation, also known as a radial track wobble. Such track wobble can also easily be detected by the same beam scanning means as used for the detection of the marks 4. Another modulation is obtained by employing variations in depth or position of the marks 4 in the plane of the recording medium 1. Fig. 1f shows a sectional view of part 3 of the record carrier 1 along a line b-b illustrating such a modulation. The reference sign 7 indicates a transparent substrate. The substrate 7 is covered with a reflective layer 8. A protective layer 9 covers the reflective layer 8. The substrate 8 is provided with optically detectable marks 4 in the form of pits. The variation of position or depth of the pits 3 is indicated by lines 10 and 11. When scanning the pattern as shown in Fig. 1f with a focused radiation beam, the variations in the plane of the marks 4 result in a focus error, which can be easily detected.

Fig. 2 shows an embodiment of an arrangement according to the invention for embedding supplemental data in an encoded signal and recording said encoded signal on a disc like record carrier as illustrated with reference to Fig.1. A first data signal D1 is received at a first input terminal 20. The data signal D1 may represent data, video or audio information etceteras. The data signal D1 may be either in analog form or digital form. If the data signal D1 is in an analog form, a digital to analog converter 22 is provided to convert the analog data signal D1 into a digital data signal. Although generally such an A/D conversion may result in a n-bits digital signal, in case of an audio signal, more often a 1-bit A/D converter is employed for conversion into a 1-bit bit stream signal BS. The bit stream signal BS has only two different representation symbols, either "0" or "1"and is therefore a binary signal. Such a 1-bit

A/D converter (also named a bit stream converter or sigma-delta modulator) may sample the audio signal D1 with a frequency which is generally a multiplicity n of a sample frequency of f_s = 44.1, 48 or 32 kHz, for instance 64*44100 = 2822400 Hz. When the audio signal D1 is supplied in digital form, sampled with a sample frequency f_s of 44.1 kHz and the samples being expressed in e.g. 16 bits per sample, this digital audio signal is over sampled with a frequency which is again a multiplicity n of this sampling frequency f_s. Resulting also in 1-bit bit stream signal BS.

Converting an audio signal into a 1-bit bit stream signal has a number of advantages. Bit stream conversion is a high quality encoding method, with the possibility of high quality decoding or a low quality decoding with the further advantage of a simpler decoding circuit.

A supplemental data signal D2, representing for example watermark data, that has to be embedded in the data signal D1 or in the corresponding bit stream BS, is received at an input terminal 23. Modifying means 24 are provided to modify the bit stream BS in order to embed the supplemental data signal D2 in the binary stream BS. The European Patent No. 706 174,in the name of applicant, document D2 in the list of referred documents that can be found at the end of this description, discloses a method of embedding such supplemental data D2 in a binary stream BS without substantially affecting the perceptual quality. Although a more detailed explanation of this modification will be given hereinafter, it is noted that no encryption of the bit stream BS is involved but only replacement of specific bits of the bit stream BS. For example a watermark bit may replace 1 bit of every 100 bits. This will only raise the quantization noise but not prohibit reproducing the data D1 in contrast to encryption. The method as disclosed in document D2, is directed to limit the raise of quantization noise to a further extent.

The supplemental data signal D2 is embedded in the bit stream BS' in accordance a specific encoding format. According to the invention, several different encoding formats may be used to this purpose. The number of possible formats is huge and can be specific for each disc or for a group of discs. Therefore format generation means 25 are provided to generate a specific encoding format represented by a format description signal F, which is being supplied to the modifying means 24. The resulting modified bit stream BS', comprising 1 bit with a frequency of $n.f_s$, may subsequently be applied to a decimation filter 26 to obtain a multi-bit stream of, for instance 16 bit bits with a frequency of f_s. This multi-bit stream is subjected, with channel encoding means 27, to appropriate channel encoding such as

for example EFM modulation for converting the 8 bit wide data bytes to 14 channel bits wide channel words. Further, error correction information is added.

In order to record the channel bits on an optically readable recording medium 1, a writing radiation beam has to be modulated in accordance with the channel bits. To this purpose modulation means 29 are provided for controlling a writing radiation beam so that the length of optically readable marks and spaces there between, arranged in a track on the recording medium1, is modulated in accordance with the obtained channel bits. This length modulation is schematically illustrated in Fig. 1b.

Thereto a writing unit 30 is provided, comprising beyond a laser unit and optical elements, also means for positioning, in accordance with drive signals submitted by the modulation means 29, a writing spot of the radiation beam in the radial direction of the circular recording medium 1. In combination with drive means 31, for rotating the recording medium 1 in accordance with drive signals obtained from the modulation means 29, the writing spot can be moved along a track. The channel bits as obtained with the modulation unit 29 control the laser unit.

Synchronization signals S generated by clock generating means 32 are used for determining the rate of writing the channel cells and therefore the channel clock period T as illustrated in Fig. 1c. In addition control means 35 are provided for generating control signals C for controlling the arrangement.

The format description information F is also supplied to second encoding means 33 for encoding this information into a second encoded signal. This second encoded signal is preferably subjected to a different modulation of the writing radiation beam then the previous mentioned length modulation by second modulation means 34. Several examples of such a different modulation are shown in Fig. 1. The examples shown comprises second modulation of the width of marks 4 (Fig. 1d), the position of the track 3 of the marks 4 (fig. 1e) or the position of the marks in the recording medium 7 (Fig.1 f). Other type of modulation may comprise placing radial oriented stripes near the center of the disc, modulating track pitch width etceteras.

A reproducing arrangement has to be capable to read besides the recorded encoded and modified bit stream, also the format description information that has been recorded with a different modulation process. This allows the decoder of the supplemental data to be programmable to support flexible encoding formats of the supplemental data. This can be even specific for each disk. The recorded bit stream with the embedded supplemental data and the corresponding encoding format is coupled to the same medium, which guarantees

comfortable usage. Both are coupled to the original legal content. By recording not only the supplemental data, such as watermark data, but also the employed format for encoding this supplemental data with other modulation techniques, merely copying of the encoded modified bit stream is not sufficient.

It is remarked that the recorded medium 1 provided with this information may be obtained either directly with for example phase change materials. Or indirectly by writing onto a mother disk with a photo sensitive layer, subsequent developing of the irradiated disk, producing a stamp of this disk and manufacturing the final recording medium 1 with the use of the stamp, by injection molding and applying a reflecting film and protecting layer.

In general, a 1-bit A/D converter may also be referred to as a unity bit encoder and bit stream signals as unity bit encoded signals. Examples of unity bit encoders are delta modulators, sigma-delta modulators, and noise shape encoders. They also belong to the family of encoders having a feed back loop. Sigma-delta modulation is envisaged for recording high quality audio on the audio version of the Digital Versatile Disk (DVD), using a sampling frequency f_s of 2822400 Hz (64*44100) and having a signal to noise ratio of 115 dB.

Fig. 3 shows an example of a sigma-delta modulator as an embodiment of the analog to digital converter 22 in Fig. 2. Alternative embodiments are disclosed in document D1. The data signal D1 is supplied to a subtractor 41 for subtracting the output signal BS from the input signal D1. The resulting error signal e is applied to a decoding filter 42 (a summer or integrator) to obtain a prediction signal which is subjected to a polarity detector 43. The polarity detector 43 produces, at a rate determined by the sampling frequency f_s, an output sample +1 or −1, in dependence on the polarity of the prediction signal. In this embodiment, a multiplexer 44 constitutes the modifying means 24 of Fig. 1. This multiplexer 44 replaces selected bits of the polarity detector 43 output (for example each 100^{th} bit) by a watermark bit pattern D_2 in response to a selection signal SEL. In practice, with the sigma delta modulator shown in Fig. 3, a signal to noise ratio of 115 dB is obtained for encoding audio signals at a sampling frequency f_s of 2822400 (64*44100) Hz. It has been found that replacing 1 sample per 100 samples increases the synchronization noise by only 1 dB. This corresponds with a watermark bit rate of 28000 bits/sec.

Another example of embedding watermark data D_2 is to invert samples of the encoded signal y, the watermark data D_2 being represented by the number of bit periods between successive inverted samples.

Fig. 4 shows an example of an input waveform 51 encoded with the embodiment shown in Fig. 3. The input waveform 51 corresponds with the input signal D1 in

Fig. 3, while numeral 52 denotes the encoded output signal, corresponding with the bit stream BS in Fig. 3. The sigma delta modulator produces more positive samples as the input signal becomes larger. A shown, an input voltage of –0,5V is encoded as a sequence of three –1V pulses and one +1V pulse, the input voltage of 0V is encoded as an alternating pattern of –1V and +1V pulses (apart from an embedded watermark pulse 54) , and the input voltage of +0,5V is encoded as sequence of three +1V pulses and one –1V pulse. The encoded signal is decoded again at a receiving end by reshaping the received pulses and passing them through a low-pass filter. In the embodiment of Fig. 3, the encoded signal is demodulated by averaging 13 samples of the bit stream 52. Numeral 53 denotes the reconstructed signal, apart from the time delay caused by the averaging operation.

Watermarking in this example is performed by replacing a –1 sample by a +1 sample. Numeral 54 denotes such a watermark sample. The alternating pattern of +1V and –1V pulses is clearly interrupted. However, the effect of embedding such a watermark is limited, as the reconstructed signal 53 still resembles the input signal 51. This is due, as disclosed more in detail in document D1, that the effect is fed back, inside the feedback loop, to the input and compensated by subsequent encoding the input signal after the watermark insertion.

It has to be understood, that although the invention is illustrated with embodiments employing the method of encoding and watermarking as described in the above, the invention is not limited thereto.

The method to insert embedded data is not only very flexible: the number and exact places of the embedded data can be chosen with a large degree of freedom. The selection signal SEL in Fig. 3 determines which bits of the bit stream are watermark bits. This information SEL is enclosed in the general form of format description information F in Fig, 2, which is being generated by the format generating means 25. In a most simple from this format description information F may only comprise a number N, indicating that the Nth bit of the bit stream is a watermark bit. For instance by replacing the 6^{th}, 16^{th} and 26^{th} bit of a bit stream by a-1V, -1V and +1V bit respectively, a corresponding watermark pattern D_2 = '001'is obtained.

Other methods for embedding may be used, such as for example inverting selected samples of the bit stream, the watermark data being represented by the number of bit periods between successive inverted samples.

It is obvious that a more complex format may be employed for embedding watermark data if a higher degree of security is required. In stead of a fixed number N, a

sequence of varying numbers may be employed, the sequence being generated in accordance to a specific algorithm.

However, according to the invention, a secure protection is obtained by allowing a flexible format for embedding watermark data. This requires that the format description has to be recorded in addition in order to allow to inform a programmable decoder at a reproducing arrangement. As mentioned with reference to Fig.2, second encoding means 33 and second modulating means 34 are employed to this purpose in order to obtain even a more secure protection. Only dedicated reproducing arrangements that are provided with special detecting means would enable extraction of the embedded watermark data.

It is remarked, that embedding watermark data, or other control data in the manner described, does not involve encrypting the main audio, video or general data as such. The encoded bit stream is only affected by a small amount of noise, leading to an equal small reduction in a signal to noise ratio. Encryption and decryption however require more data processing circuitry, leading to higher cost prices.

To that end, the step of modifying the encoded signal is performed inside the feedback loop of the encoder. Any modification of the encoded signal for the purpose of watermarking is thus fed back and will be compensated in a subsequent coding operation.

Although, the invention will be illustrated with embodiments employing the method of encoding and watermarking as described in the above-mentioned application, the invention is not limited thereto.

Fig. 5 shows an arrangement according to the invention for reproducing encoded data and extracting supplemental data from a record carrier of the optically readable type.

A disc 1 provided with optically readable marks, such as illustrated with in Fig. 1, is rotational driven by disc rotating means 61. An optical pick up unit 62 radiates the disc 1 with a radiation beam generated by, for example a semi conductor laser. The radiation beam or the optical pick up unit 62 is movable in radial direction of the disc 1. The disc 1 is being scanned with the radiation beam along the circular track 2. The radiation reflected by the disc 1 is detected by a radiation sensitive detector in the optical pick up unit 62 and converted in a electrical detection signal. The variation in this electrical detection signal is reflecting the modulation in the detected radiation as induced by optically detectable marks on the disc 1. The detection signal is supplied to first demodulation means 64 for deriving a focus control signal and a tracking error signal, both signals used to control the optical pick up unit 62. In addition a velocity control signal is supplied to the disc rotating means 61. A synchronization

signal S, comprising for example the sampling frequency f_s, is derived by the demodulation means 64 from the detection signal. This signal f_s is used, amongst others, for decoding purposes in the decoders.

The first demodulating means 64 are further adapted to detect the changes in the electrical detection signal induced by variations in the length of said marks and space between the marks. Fig 1b illustrates the arrangement of marks 4 while Fig. 1c depicts an example of a corresponding electrical detection signal 6. In combination with the obtained synchronization signal S, which determines the data clock period T, the channel bits are derived from the electrical detection signal. The channel bits are consequently converted to data bits with first decoding means 65, employing for instance EFM demodulation as known from Compact Disc (CD) data processing or EFM+ demodulation as known from Digital Versatile Disc (DVD) data processing. Also error correction is being employed. The resulting data stream comprises at this stage 16 bits wide words at a sampling frequency f_s. In case of audio data, as an example, this multi-bit stream is converted to a binary bit stream with an interpolation filter 66, with a sampling frequency of $n.f_s$. This bit stream is applied to a 1-bit D/A converter 67, to reconvert the bit stream audio signal into the original analogue audio signal D_1.

According to the invention, second demodulation means 68 are provided to derive information from the variations in the detection signal induced by variations other than of the length of the marks and spaces between the marks. Such as, for example, variations in width, radial position or depth as illustrated in Fig. 1d, Fig. 1e and Fig. 1f, respectively. A variation in radial position may be separated from the variation in length, if the radial variation exhibits another frequency range, by a tuned band pass filter. Variations in depth or width may be separated likewise. Further other type of variations might be present such as for example marks extending in radial direction on the disc 1.

The signal resulting from a demodulation of the detection signal by the second demodulating means 68, for example channel bit cell signals, comprises encoded format description information as mentioned before. This information is decoded with second decoding means 69 into data word representing the format description information. The second decoding means 69 supplies, on the basis of the received format description information, a format description signal F to a programmable decoder 70. With this signal F, the programmable decoder 70 is programmed in such a way that supplemental data embedded in a bit stream according to the corresponding format, can be extracted therefrom. To this purpose the programmable decoder 70 receives the decoded bit stream from the first decoding means 65.

Employing the format description signal F, the programmable decoder 70 is instructed or programmed such that supplemental data embedded in this bit stream in accordance with the format description represented by the signal F, is extracted therefrom. The format description information F may comprise a complete description of the employed format for encoding the supplemental data or only a portion thereof. For instance, the format description information F may only be a number or a series of numbers denoting which bits of the bit stream comprises supplemental data, as described before, while the programmable decoder 70is adapted to handle these numbers. The format description information may also comprise only a part of the total format description required for decoding. In that case the additional part may be stored previously in the second decoder 70.

Fig. 6 illustrates in more detail an embodiment of the programmable decoder 70 in Fig. 5, for extracting an embedded watermark from a delta modulated bit stream. The modified encoded bit stream BS', such as generated by the first decoding means 65, is applied to the data input of a register 80 clocked by a selection signal SEL. The output of the register 80 is the watermark pattern or other control data D_2. The selection signal SEL determines which bits of the bit stream BS' are watermark bits. It is generated by a divider stage 81 which divides the sample frequency f_s, by a number n, for example 100, specified by the format description signal F such as generated by the second decoding means 70. This selection signal SEL is synchronized with the corresponding signal in the recording arrangement. Synchronization can be achieved by accommodating a predetermined synchronization bit pattern in the watermark signal D_2. In such an embodiment, a sync detector 82 detects said pattern and changes the phase of divider stage 81 until the sync pattern is detected.

Other detailed embodiments for extracting the watermark data D_2 may be found in document D2. It is remarked that the functionality of several means may be combined in one means, or even some means may be even skipped. For instance the first decoding means 65 and the programmable decoding means 70 may be combined in one decoding arrangement. Further, the first and second demodulating means 64 and 68 may be arranged in practice in one unit.

Another embodiment of a reproducing arrangement is obtained when the recording arrangement as illustrated with reference to Fig. 2 is used as a home recorder and only records a so-called public watermark in the bit stream according to a public format. This would enable that all discs are watermarked, also home-recordings. A corresponding reproducing arrangement such as described with reference to Fig. 5 that is combined with the same recording arrangement could detect this public watermark because its format is known.

In contrast, a so-called private watermark and corresponding format could be reserved for official releases from industry only.

In stead of or in addition to watermark information D_2, control information may be embedded in the encoded bit stream BS'. This control information may then be used to control the reproducing arrangement.

Fig. 7 illustrates a method according to the invention for embedding supplemental data in an encoded signal. In a first step 91 (1ST_DAT) main first data such as video, audio or general data is received. The first data is encoded in step 93 (ENC_1ST_F) in accordance to a first format, such as for example employed in CD or DVD, into channel data adapted for recording or transmitting. In step 92 (SUP_DAT) supplemental data to be embedded in the main data is received. In step 94 (2ND_F) a second format is generated, that is used as a prescription for modifying in step 95 (MOD) the encoded first data in order to embed the supplemental data therein. Description information characterizing the second format or a part therefrom, is also encoded in step 96 (ENC_ 3RD_F) in accordance to a third format (which may be identical to the first format) into channel data. Meanwhile, the modified encoded first data is modulated in step 97 (1ST_MOD) in accordance with a first modulation process into signals adapted for recording on a specific recording medium or transmitted on a transmission channel. The encoded second format description information is modulated in step 98 (2ND_MOD) in accordance with a second, different modulation process also into signals adapted for recording of a specific recording medium. Both signals are recorded in step 99 (W) by a same recording process, such as for example with an optical scanning radiation beam. Although both recording processes may be performed separately or being even different from each other. Preferably, the same recording process is employed as this has the advantage that reproducing can also being performed with one reading process.

It is remarked that in the above-mentioned embodiment of a method of embedding supplemental data, is only an example. Some steps may be performed either in parallel or in series, without departing from the invention.

Although the invention has been described with reference to preferred embodiments thereof, it is to be understood that these are not limitative examples. Thus, various modifications may become apparent to those skilled in the art, without departing from the scope of the invention, as defined by the claims. The invention can be implemented by means of both hardware and software, and that several "means" may be represented by the same item of hardware. Further, the invention lies in each and every novel feature or combination of features. It is also remarked that the word 'comprising' does not exclude the

presence of other elements or steps than those listed in a claim. Any reference signs do not limit the scope of the claims.

LIST OF REFERRED DOCUMENTS:

(D1) European Patent Application Number 98900036.9, in the name of applicant, (PHN16209)
(D2) European Patent 706 174
(D3) European Patent Application Number 91203147.3), in the name of applicant, (PHN13922).

CLAIMS:

1. A method of embedding supplemental data in an encoded signal and recording said encoded signal on a disc like record carrier, such as an optically readable disc, comprising the steps of

encoding first data in accordance with a first format for obtaining a first encoded signal,

modifying the first encoded signal in accordance with a second format for embedding supplemental data therein,

recording the modified first encoded signal on the record carrier by applying marks of the type having different physical characteristics relative to the surrounding area, wherein said marks are arranged in circular tracks on the disk and wherein the length and spacing of marks in the track direction are modulated in accordance with the modified encoded signal in a first modulation process,

characterized by,

generating a second signal representing format description information related to the second format for enabling future extraction of the supplemental data ,

encoding said second signal for obtaining a second encoded signal and

recording the second encoded signal on the record carrier by either applying marks of the same type modulated in accordance with the second encoded signal in a second modulation process that is different from the first modulation process or applying marks of a second type having different physical characteristics with respect to the first type, modulated in accordance with the second encoded signal.

2. A method according to claim 1, wherein the

recording of the modified first encoded signal and the second encoded signal comprises applying marks subjected to both the first and second modulation process.

3. A method according to claim 2, wherein the second modulation process comprises modulation of the mark geometrical structure in a non-tangential direction.

4. A method according to claim 3, wherein the second modulation process comprises mark width modulation.

5. A method according to claim 3, wherein the second modulation process comprises modulation of the radius of the tracks of the marks.

6. A method according to claim 1, wherein the second modulation process comprises applying marks extending in a radial direction in a central region of the recording disk.

7. A method according to claim 1, wherein the encoding of the first data comprises unity bit encoding.

8. A method according to claim 7, wherein the encoding of the first data comprises sigma-delta encoding.

9. A method according to claim 1, wherein the modifying of the encoded first signal comprises selecting samples of the encoded first signal according to a selection rule and modifying said samples by samples of said supplemental data and the format description information comprises said selection rule.

10. A method according to claim 7, wherein

the modifying of the encoded first signal comprises selecting samples of the unity bit encoded first signal according to a selection rule and inverting said samples, the embedded data being represented by the number of sample periods between said successive samples and

the format description information comprises said selection rule.

11. A method according to one of the preceding claims, wherein the supplemental data comprises device control data for controlling the reproducing of the data recorded on the record carrier.

12. A method according to one of the preceding claims, wherein the second signal represents, in addition to format description information, control data for controlling the reproducing the data recorded on the record carrier.

13. An arrangement for embedding supplemental data in an encoded signal and recording said encoded signal on a disc like record carrier, such as an optically readable disc, comprising:

a first input terminal for receiving a first data signal,

a second input terminal for receiving a supplemental data signal,

first encoding means for converting the first data signal in accordance with a first format into an first encoded signal,

modifying means for modifying the first signal encoded in accordance with a second format for embedding the supplemental data therein,

recording means for recording the modified first encoded signal on the record carrier by applying marks of the type having different physical characteristics relative to the surrounding area, wherein said marks are arranged in circular tracks on the disk, the recording means further comprising first modulation means for modulating the length and spacing of the marks in a track direction in accordance with the modified encoded first signal,

characterized in that, the arrangement comprises

generating means for generating a second signal representing format description information related to the second format for enabling future retrieval of the supplemental data,

second encoding means for encoding said second signal for obtaining a second encoded signal and the recording means further comprises either

second modulation means for modulating marks of said type in accordance with the second encoded signal differently from the first modulation means and

the recording means are adapted to apply marks of said type modulated with the second modulation means on the record carrier or the recording means are further adapted to apply marks of a second type having different physical characteristics with respect to the first type, modulated in accordance with the second encoded signal.

14. An arrangement according to claim 13, characterized in that, the recording means are adapted to record the modified first encoded signal and the second encoded signal by applying marks subjected to modulation by both the first and second modulation means

15. An arrangement according to claim 14, characterized in that, the second modulation means are adapted to modulate the marks geometrical structure in a non-tangential direction.

16. An arrangement according to claim 15, characterized in that, the second modulation means are adapted to modulate the radius of the tracks of the marks.

17. An arrangement according to claim 13, characterized in that, the second modulation means are adapted to apply marks extending in a radial direction in a central region of the recording disk.

18. An arrangement according to claim 13, characterized in that, the second encoding means are adapted to unity bit encoding.

19. An arrangement according to claim 18, characterized in that, the second encoding means are adapted to sigma-delta encoding.

20. An arrangement according to claim 13, characterized in that,

the modifying means are adapted to select samples of the first encoded signal according to a selection rule and to modify said samples by samples of said supplemental data and

the generating means are adapted to generate a second signal representing format description information comprising said selection rule.

21. An arrangement according to claim 18, characterized in that,

the modifying means are adapted to select samples of the unity bit encoded first signal according to a selection rule and to invert said samples such that the embedded data is represented by the number of sample periods between said successive samples and

the generating means are adapted to generate a second signal representing format description information comprising said selection rule.

22. An arrangement according to one of the claim 13-21, characterized in that, the modifying means are adapted to embed device control data in the supplemental data for controlling a device adapted to reproduce the data recorded on the record carrier.

23. An arrangement according to one of the claim 13-22, characterized in that,

the generating means are adapted to generate, in addition to the format description information, device control data for controlling a device adapted to reproduce the data recorded on the record carrier.

24. A record carrier of the optical readable type provided with signals recorded thereon according to one of the claims 1-12.

25. A disc like record carrier, such as an optically readable disc, with recorded thereon a first encoded signal by means of a first modulation in a track direction of length and spacing of marks of the type having different physical characteristics relative to the surrounding area wherein said marks are arranged in circular tracks on the record carrier, wherein

the first encoded signal represents first data encoded in accordance with a first format and supplemental data embedded therein in accordance with a second format, characterized in that,

a second encoded signal is recorded on the record carrier by means of either a second modulation different from the first modulation of marks of said type, or with marks of a second type having different physical characteristics with respect to the first type, wherein

the second encoded signal represents format description information related to the second format for enabling extraction of the supplemental data.

26. A disc like record carrier according to claim 25, characterized in that, the first and second encoded signals are recorded thereon with marks of said type being subjected to both the first and second modulation.

27. A disc like record carrier according to claim 26, characterized in that,

the second modulation comprises modulation of the marks geometrical structure in a non-tangential direction.

28. A disc like record carrier according to claim 27, characterized in that, the second modulation comprises mark width modulation.

29. A disc like record carrier according to claim 25, characterized in that, the second modulation comprises applying marks extending in a radial direction in a central region of the disk like record carrier.

30. A disc like record carrier according to claim 25, wherein the first data are unity bit encoded.

31. A disc like record carrier according to claim 30, wherein the first data are sigma-delta encoded.

32. A disc like record carrier according to claim 25, characterized in that,
the first encoded signal comprises samples selected in accordance to a selection rule, wherein
the samples are modified in accordance with the supplemental data and
the format description information comprises the selection rule.

33. A disc like record carrier according to claim 30, characterized in that,
the first encoded signal comprises inverted samples of the unity bit encoded first signal selected in accordance to a selection rule wherein the number of sample periods between successive samples represents the embedded data and
the format description information comprises said selection rule.

34. A disc like record carrier according to one of the claims 25-33, characterized in that the supplemental data comprises device control data adapted to control the reproducing of the data recorded on the record carrier with a reproducing device.

35. An arrangement for reproducing data recorded on a disc like record carrier, such as an optically readable disc, comprising
means for rotationally driving the disc like record carrier wherein data is recorded in the form of marks of the type having different physical characteristics relative to the surrounding area,
a pick up unit for scanning marks of said type and converting a received signal into an electrical detection signal,

first demodulating means for demodulating the electrical detection signal for retrieval of a data signal resulting from a first modulation in a track direction of the length and spaces of marks arranged in circular tracks on the record carrier,

first decoding means for decoding from said data signal, a first data signal encoded according to a first format and embedded supplemental data signal encoded according to second format ,

signal reproducing means for reproducing signals according to the first data signal,

control means for receiving the embedded supplemental data signal and controlling the arrangement,

characterized in that, the arrangement comprises either

second demodulating means for demodulating the electrical detection signal for extraction of second data signals resulting from a second, different modulation of marks of said type or said pick up unit is adapted for scanning marks of a second type having different physical characteristics with respect to the first type and converting a received signal into second data signals,

second decoding means for decoding from said second data signals a format description information signal related to the second format,

the control means comprise programmable decoding means for extraction and decoding the embedded data, and

the programmable decoding means are adapted to receive said format description information signal and to decode and extract the embedded data according to said format description information signal.

36. An arrangement according to claim 35, characterized in that, the demodulating means are adapted to demodulate the electrical detection signal resulting from pits of said type being subjected to both the first and second modulation.

37. An arrangement according to claim 36, wherein the second demodulation means are adapted to demodulate the electrical detection signal resulting from modulation of the mark geometrical structure in a non-tangential direction.

38. An arrangement according to claim 37, wherein the second modulation comprises marks width modulation.

39. An arrangement according to claim 35, characterized in that, the second demodulation means are adapted to demodulate the electrical detection signal resulting from marks extending in a radial direction in a central region of the disc like record carrier.

40. An arrangement according to claim 35, characterized in that, the first decoding means are adapted to decode unity bit encoded data signals.

41. An arrangement according to claim 35, characterized in that, the decoding means are adapted to decode sigma-delta encoded data signals.

42. An arrangement according to claim 35, wherein the first data signal comprises samples selected in accordance to a selection rule, wherein the samples are modified in accordance with the supplemental data and

the format description information comprises the selection rule.

43. An arrangement according to claim 40, wherein the first data signal comprises inverted samples of a unity bit encoded first signal selected in accordance to a selection rule wherein the number of sample periods between successive samples represents the embedded data signal and

the format description information signal comprises said selection rule.

44. An arrangement according or one of the claims 35-43, characterized in that the supplemental data signal comprises device control data adapted to control the arrangement.

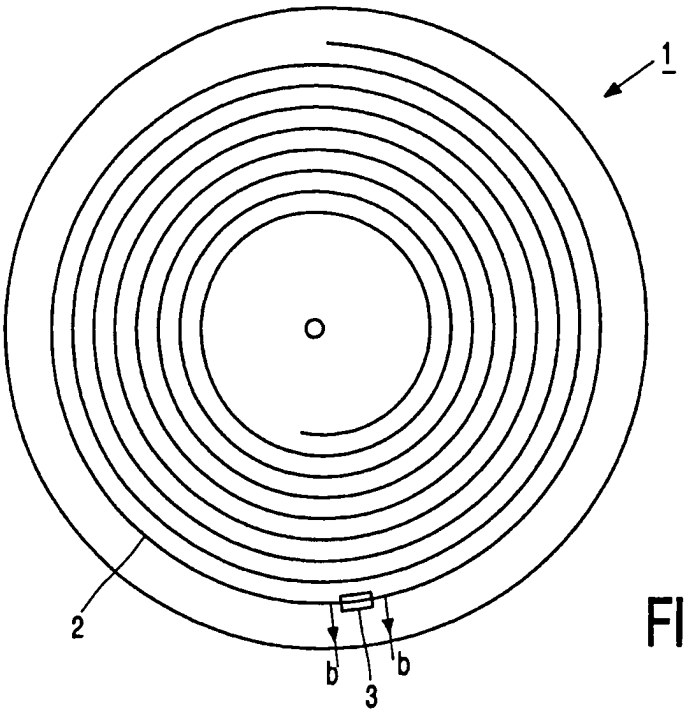


FIG. 1a

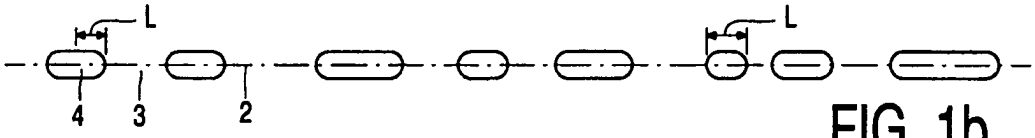


FIG. 1b

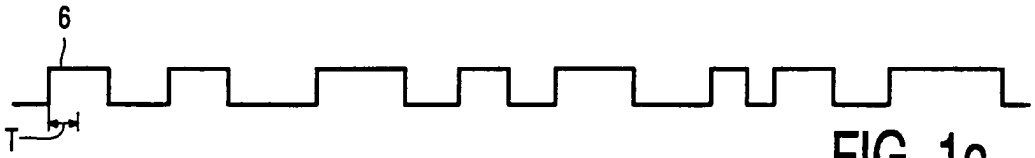


FIG. 1c

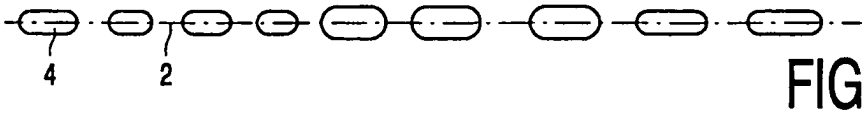


FIG. 1d

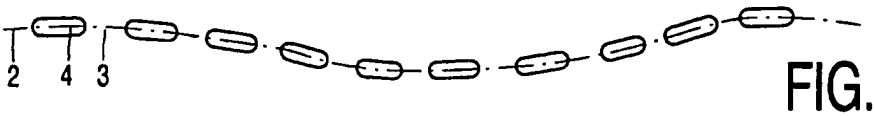


FIG. 1e

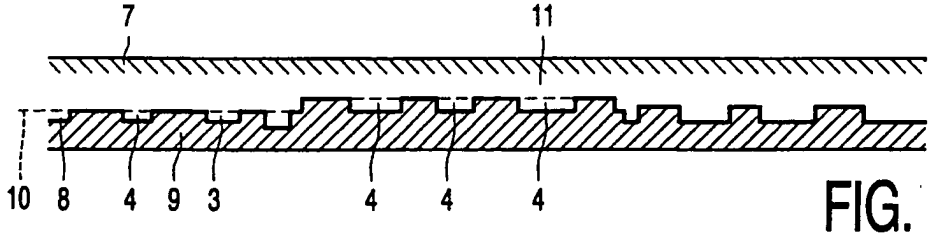


FIG. 1f

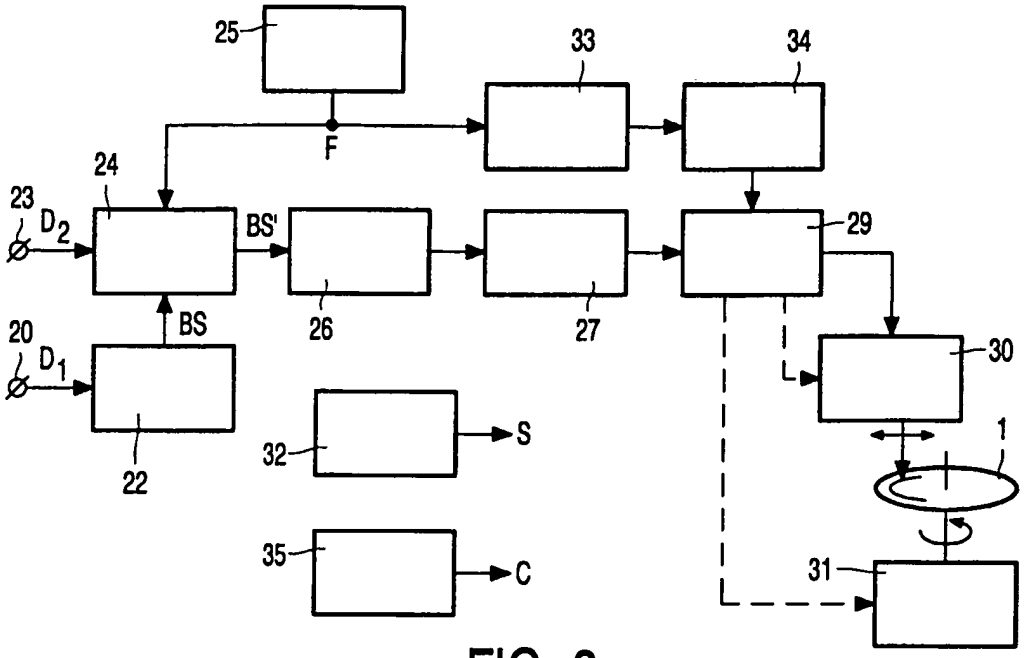


FIG. 2

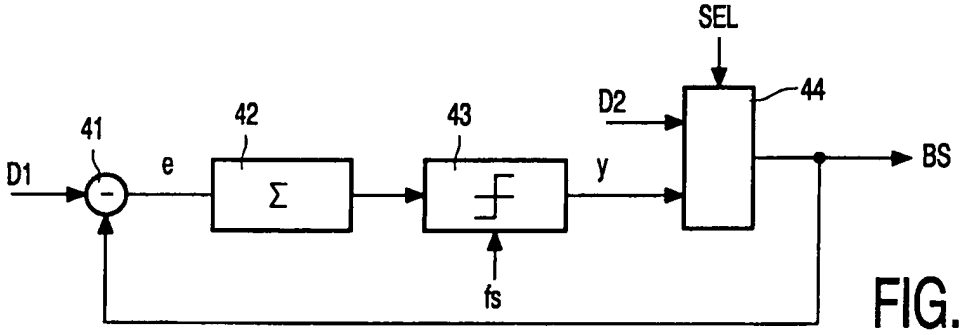


FIG. 3

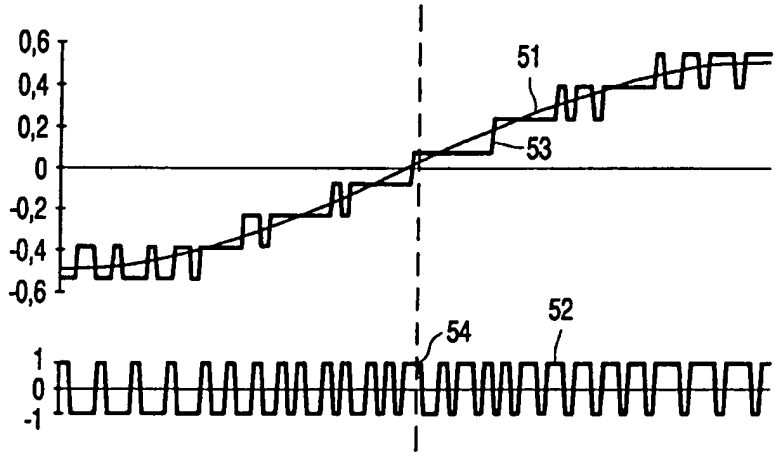


FIG. 4

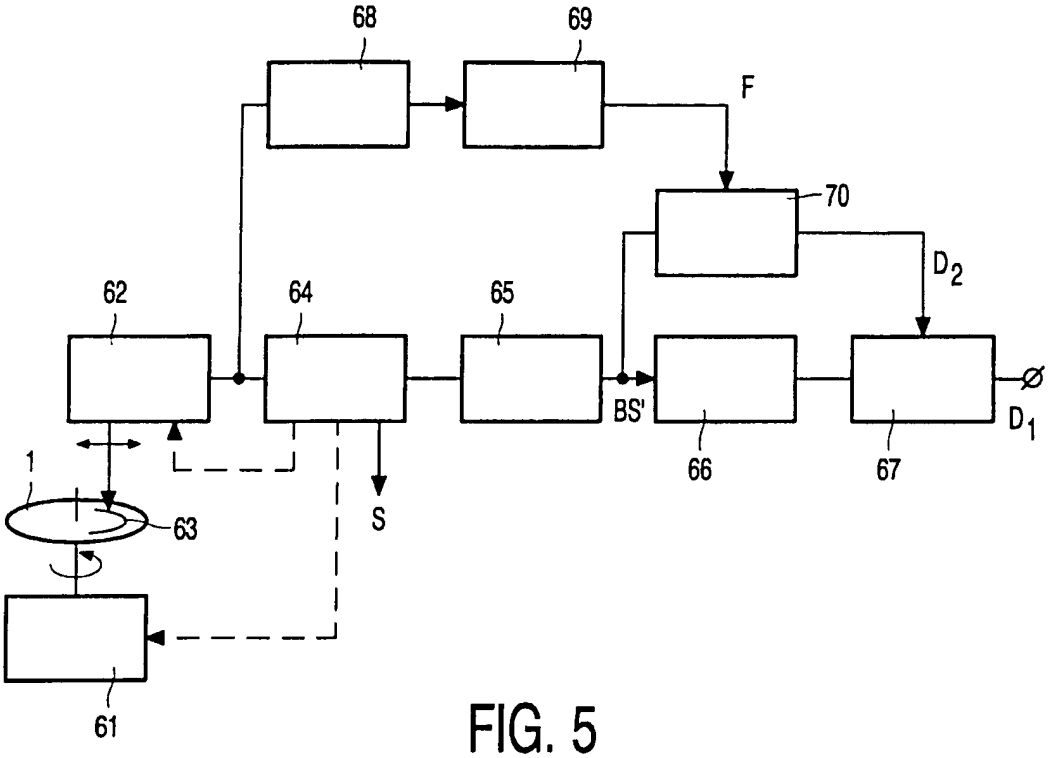


FIG. 5

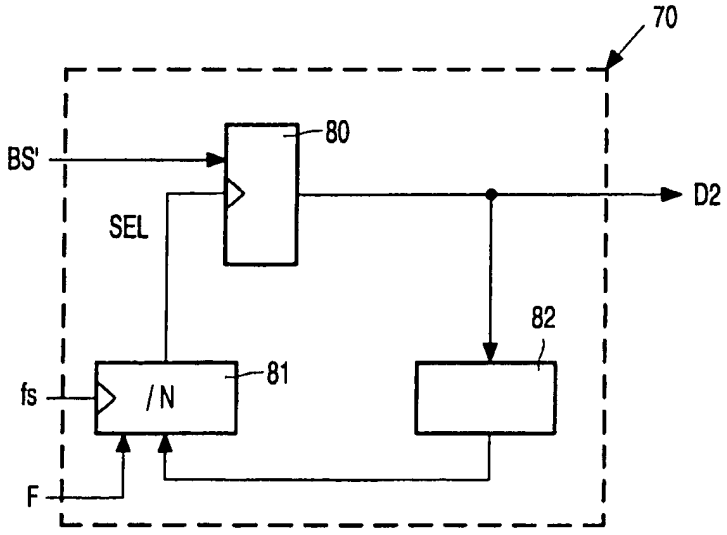
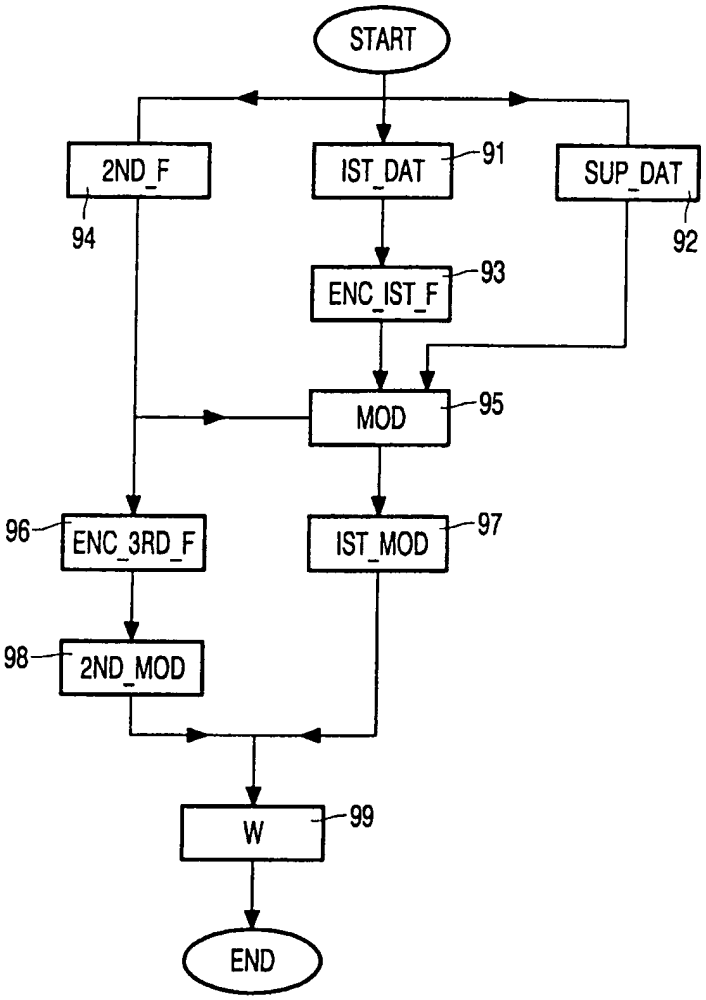


FIG. 6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SUP_DAT
91
94
92
ENC_IST_F
93
MOD
95
96
ENC_3RD_F
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97
98
2ND_MOD
W
99
END

FIG. 7